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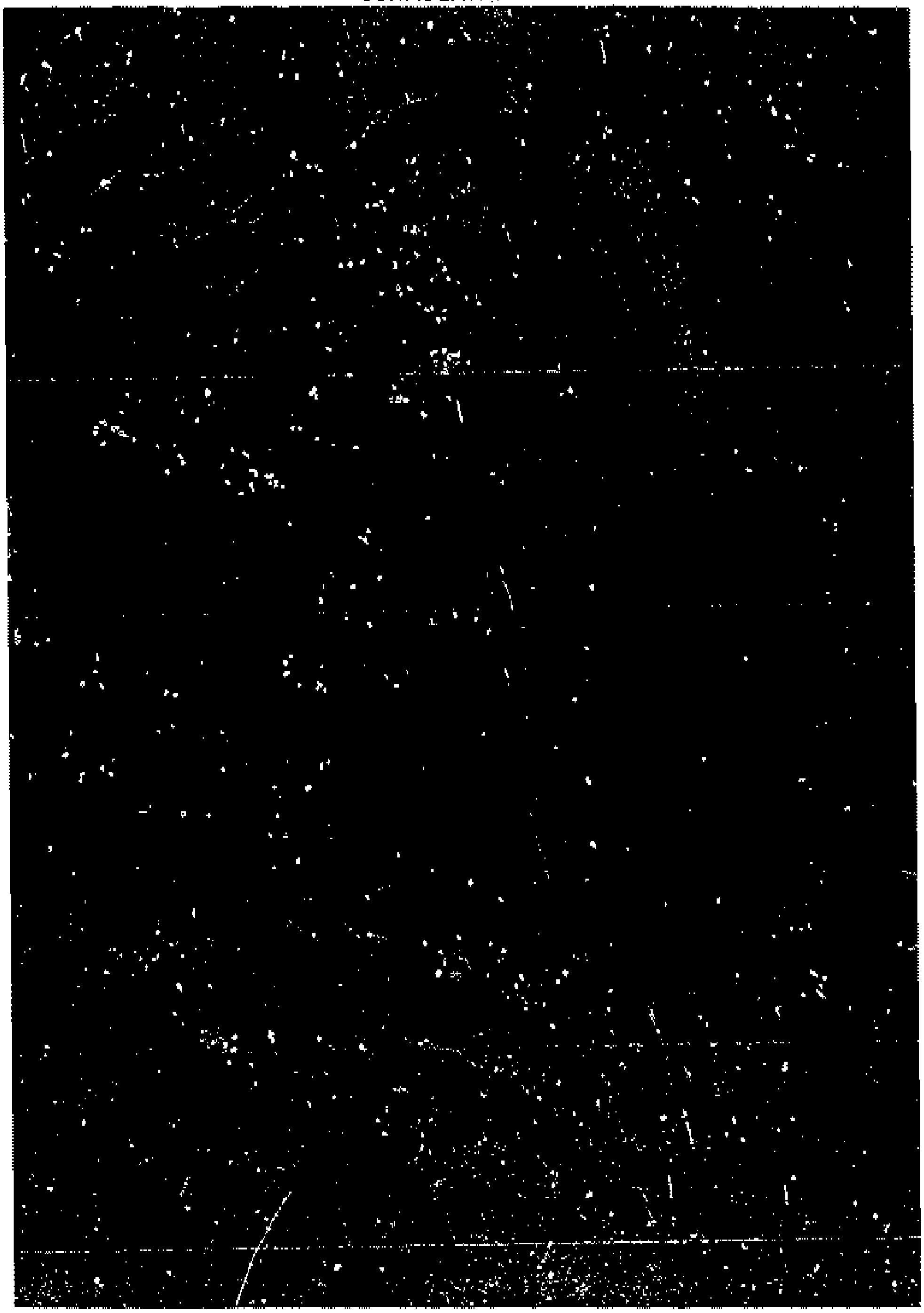

EVALUATION OF THE USEFULNESS OF THE MOL TO ACCOMPLISH EARLY NASA MISSION OBJECTIVES (u)

VOLUME 8
SUPPORT SYSTEMS, GEMINI B, AND TITAN III-M (u)

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MAY 1967

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DOUGLAS

MISSILE & SPACE SYSTEMS DIVISION

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Section 1
GEMINI B

1.1 GEMINI B DEFINITION (U)

(C)(Gp-4) The primary function of the Gemini B is to transport the crew during launch, early orbit, re-entry, and return to Earth. The Gemini B is a modified version of the NASA Gemini, plus a new adapter (see Figure 1-1). The primary change is the construction of an access hatch in the heat shield. The access hatch provides the entrance to a pressurized tunnel to be used by the crewmen to transfer from the Gemini to the laboratory vehicle pressurized compartment. The Gemini B adapter requirements are significantly different from those of the NASA Gemini, primarily because of Gemini B's use with the laboratory vehicle rather than as an autonomous spacecraft. This results in a simpler and smaller adapter which still utilizes the major NASA Gemini subsystem components. Other major modifications include elimination of the rendezvous and radar subsystem and the orbital attitude and maneuvering subsystem. The requirements imposed upon the Gemini system are summarized in Figure 1-2.

(C)(Gp-4) A target weight statement for the baseline Gemini B AVE is given in Figure 1-3.

1.2 MISSION CAPABILITIES (U)

1.2.1 Baseline Escape System (U)

(C)(Gp-4) The change from the Gemini launch vehicle (GLV) to the Titan III-M launch vehicle imposes different environments on the Gemini escape system. The addition of guidance and control redundancy, minor malfunction detection system (MDS) changes to the Titan III-M, and two more retrograde motors (required for polar re-entry) permits use of the existing Gemini escape system. Changes for MOL are primarily in the operational utilization of this system. The crew escape concept consists of four different modes,

GEMINI B REQUIREMENTS

MISSION

- O DESIGN ORBITS – 220 NMI CIRCULAR ORBIT MAXIMUM WITH INCLINATIONS FROM 65° TO 125°
- O 30-DAY ON-ORBIT STORAGE
- O 14-HOUR LOITER CAPABILITY
- O POLAR ORBIT RE-ENTRY
- O WATER RECOVERY
- O CAPABILITY FOR ADDING RENDEZVOUS PROVISIONS

MAJOR CHANGES FROM NASA GEMINI

- O TITAN IIIM LAUNCH VEHICLE
- O MODIFY HEAT PROTECTION SYSTEM FOR POLAR ORBIT RE-ENTRY AND TO IMPROVE L/D CAPABILITY
- O HEAT SHIELD HATCH
- O DELETE RENDEZVOUS, RADAR, AND OAMS SUBSYSTEMS
- O NEW ADAPTER

FIGURE 12

depending on position in the launch trajectory. The different modes of escape are defined in Figure 1-4.

(C)(Gp-4) The rideout mode for altitudes between ,000 and 140,000 ft consists of thrust terminating the booster and using the residual thrust to control the flight vehicle; the Gemini B remains attached until the drag level decays sufficiently to permit escape by salvo firing the retrograde motors. Certain launch vehicle malfunctions preclude the use of this mode, that is, control failures causing engine handovers. However, the redundant guidance and control system minimizes these kinds of failures. The inherent strength of the Gemini B also permits survival with breakup of the Titan III while attached except for the worst cases of upper-stage explosion at low altitude.

1.2.2 Crew Transfer (U)

(C)(Gp-4) The crew moves between the Gemini B and the laboratory vehicle through a tunnel in the adapter. Entry to this tunnel is through a 24-in. diam hatch between the crew seats in the upper portion of the large pressure bulkhead and through a similar hatch in the heat shield. The adapter tunnel is an aluminum semimonocoque shell with an internal diameter of 31.2 in. It is supported by the retrorocket beams and structural rings of the adapter. Pressure seals are provided at each end of the tunnel, at the heat shield, and at the laboratory vehicle interface.

(C)(Gp-4) Thermotight hatches are provided for both the heat shield and the pressure bulkhead at the Gemini B cabin. The heat-shield hatch is fabricated of the same material as the bulkhead hatch and is locked in place by a cammed-dog mechanism. The aluminum honeycomb bulkhead hatch incorporates a split-ring latch mechanism and a pressure-equalization valve. During crew-transfer operations, the heat-shield hatch is stowed in the Gemini B tunnel. The upper inboard corner of each ejection seat is cut back to provide clearance for crew passage through the hatches. The modes of transfer are discussed in greater detail in Figure 1-5.

1.2.3 Re-Entry Capability (U)

(C)(Gp-4) Minor modifications in the heat protection system, coupled with the two additional retrograde motors, provide the capability to re-enter from polar

(GP-4)

BASELINE ESCAPE SYSTEM

MODE A -- OFF PAD TO AFTER STAGE I IGNITION

- SPACECRAFT ABORT BY SALVO FIRING 6 RETROMOTORS
  - FOR OFF PAD AND JUST AFTER LIFTOFF, SEATS MUST BE USED AFTER ESCAPE IN SPACECRAFT
  - IN HIGH-Q REGION, RIDEOUT MODE PRIOR TO SPACECRAFT ABORT

MODE B -- STAGE I IGNITION TO ABOUT 22,000 FPS

- SALVO FIRE 2 RETROMOTORS, RE-ENTRY AND NORMAL RECOVERY

MODE C -- ABOUT 22,000 FPS TO ORBIT

- SEPARATION BY SEPARATION MOTORS, RETROFIRE, RE-ENTER, AND NORMAL RECOVERY

MODE D -- OPTIONAL IF MODE C TOUCHDOWN POINT IS UNACCEPTABLE

- SEPARATE FROM TITAN III AND POSIGRADE OR ADD ΔV WITH LABORATORY ACTS
- COAST ONE OR TWO ORBITS, RETROGRADE, RE-ENTER AND NORMAL RECOVERY

FIGURE 1-4

Military Uses of Space: 1946-1991

Published by:
Chadwyck-Healey Inc., 1101 King Street, Alexandria, Virginia 22314

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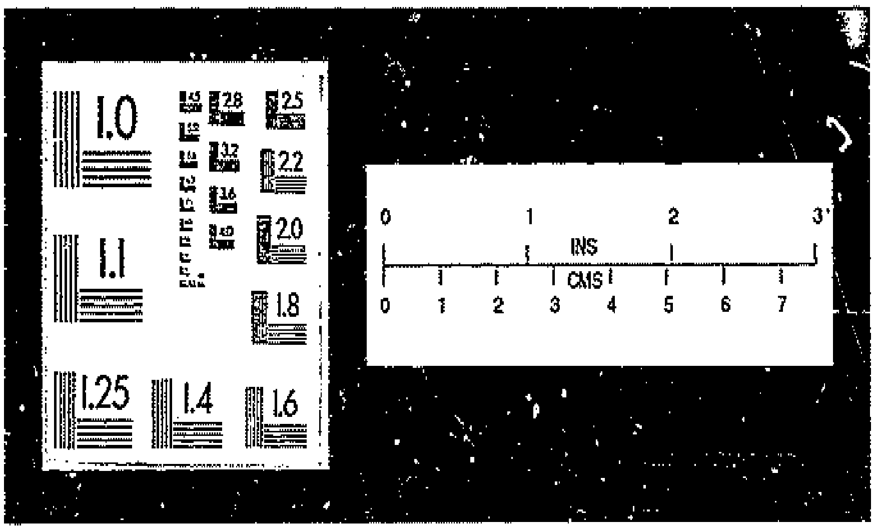

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CREW TRANSFER

NORMAL MODE

- INTERNAL PRESSURIZED TUNNEL BETWEEN GEMINI B AND LABORATORY REQUIRES HATCH IN GEMINI B HEAT SHIELD AND PRESSURE BULKHEAD
- PROCEDURE
  - FIRST CREW MEMBER TO TRANSFER
    - OPENS HATCHES
    - ACTIVATES SYSTEMS OF EITHER LABORATORY OR GEMINI B (DEPENDING ON DIRECTION OF TRANSFER)
    - HAS UMBILICAL ATTACHED
  - SECOND CREW MEMBER TO TRANSFER
    - DEACTIVATES SYSTEMS OF EITHER GEMINI B OR LABORATORY (DEPENDING ON DIRECTION OF TRANSFER)
    - TRANSFERS WITH UMBILICAL
    - CLOSES HATCH(ES)

FIGURE 1-5 (Page 1 of 2)

CREW TRANSFER (CONT)

BACK-UP MODE

- EXTRAVEHICULAR
- USES GEMINI B MAIN EGRESS HATCHES
- USES LABORATORY HATCH

EMERGENCY MODE

- USING INTERNAL TUNNEL
- SHIRTSLEEVE (EXAMPLE, NO PRESSURE SUIT)
  - RE-ENTERS SHIRTSLEEVE

FIGURE 1-5 (Page 2 of 2)

orbits. The Gemini B can safely re-enter from circular and elliptical orbits that have a minimum perigee altitude of 70 nmi and a maximum apogee altitude of 220 nmi for inclinations up to 100^{o} (Figure 1-6).

(C)(Gp-4) The landing system is identical to that of NASA Gemini. The system consists of an 8.3-ft diam drogue stabilization parachute, an 18.3-ft diam pilot parachute, and an 84.2-ft diam main parachute. Water landing will be employed. Items required for post-landing recovery and survival are identical to the NASA Gemini. These include recovery light, dye markers, food, water, and survival kits.

1.3 SUBSYSTEMS (U)

1.3.1 Re-Entry Module Structure and Heat Shield (U)

(C)(Gp-4) The basic NASA Gemini re-entry module structure is used for the Gemini B. Changes are required to incorporate the internal crew-transfer system (see Figure 1-7). This modification entails adding a circular hatch in the main pressure bulkhead and modification to the beam structure between the two access hatches. In addition, the nose-docking provisions and the food-storage provisions are eliminated. A minor modification will be made to the re-entry module (shown on Figure 1-8) adapter attachment lower fairing, and to the shingles just forward of this fairing to permit utilizing the full lift-to-drag ratio capability of the Gemini B. This change is required because of a design deficiency uncovered on GT-2. A hatch must also be added to the heat shield for crew transfer.

(C)(Gp-4) The Gemini re-entry module is made up of three primary sections: recovery, re-entry control system, and cabin sections. The cabin section is a truncated cone with an internal pressure vessel which is shaped to provide an adequate crew station with a proper water-flotation attitude. This configuration allows space between the pressure vessel and the outer conical shell for the installation of equipment. Outlining the basic cabin and equipment bays is a welded frame section of ring segments, stringers, and longerons. Titanium is the major structural material with René 41 shingles covering the external surface. Pressure bulkheads are attached to each end of the cabin. Two egress hatches on the top side of the cabin are of sufficient size to

(GP-4)

RE-ENTRY CAPABILITY

SPACECRAFT MODIFICATIONS

- NO INCREASED HEAT PROTECTION
  - NASA HEAT SHIELD CONSERVATIVELY DESIGNED
- TWO ADDITIONAL RETROGRADE MOTORS

CAPABILITY

- ELLIPTICAL AND CIRCULAR ORBITS
  - MINIMUM PERIGEE ALTITUDE - 70 NMI
  - MAXIMUM APOGEE ALTITUDE - 220 NMI
  - INCLINATION - UP TO 100°
- MISSION RULES ARE REQUIRED
  - VARY NUMBER OF RETROMOTORS FIRED WITH ORBIT AND/OR POSITION ON ORBIT
- RETRO GRADE MOTORS PROVIDE 380 FPS ΔV CAPABILITY

LANDING AND RECOVERY

- SAME AS NASA GEMINI

FIGURE 1-6

RE-ENTRY MODULE STRUCTURE AND HEAT SHIELD

BASICALLY THE SAME AS NASA GEMINI

MAJOR CHANGES DUE TO CREW-TRANSFER REQUIREMENT

- HATCH IN MAIN PRESSURE BULKHEAD
- HATCH IN HEAT SHIELD
- MODIFY MAIN CENTERLINE BEAM BETWEEN HATCHES

CHANGES FOR POLAR RE-ENTRY

- MODIFY ATTACHMENT FAIRING TO USE MAXIMUM L/D CAPABILITY
  HYPERSONIC L/D:

NASA	-	0.10 TO 0.13
GEMINI B	-	0.19 TO 0.24

- BERYLLIUM SHINGLES MAY NEED MODIFICATION ON LEEWARD SIDE BASED ON GT-2 TEST RESULTS

MINOR CHANGES

- DELETE NOSE-DOCKING PROVISIONS
- DELETE FOOD-STORAGE PROVISIONS

FIGURE 1-7

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Section 2

TITAN III-M

2.1 TITAN III-M DEFINITION (U)

(U) The Titan III-M (Figure 2-1) is an improved version of the Titan III-C launch vehicle. The performance has been uprated to perform the MOL mission and systems added to man-rate the launch vehicle. Seven-segment SRM's have replaced the 5-segment versions, providing higher thrust levels and added propellant weight. The first-stage engine expansion ratio has been increased from 8:1 to 15:1, providing an increase in specific impulse of about 10 sec. Also, the first stage was lengthened and the propellant loading increased by 40,000 lb. The transtage was not included in Titan III-M version, since there is some payload degradation to low-altitude orbits and since there would be a large increase in bending moment resulting from the increased vehicle length.

(U) The MDS was added to the Titan III-M version to automatically shutdown the engines in the event of a critical malfunction. Redundancy in the control systems was included to minimize first-stage engine hardover caused by control failure, which in some cases is catastrophic. A backup launch guidance system is included in the Gemini B system for the Titan III-M. These changes are summarized in Figure 2-2.

2.2 TITAN III-M PERFORMANCE (U)

(U) Performance capabilities of the Titan III-M launch vehicle are presented in Figures 2-3 and 2-4. In Figure 2-4, the payload is shown as a function of circular-orbit altitude for an east launch from ETR. The Titan III-M must use a direct ascent mode rather than a Hohmann transfer or elliptic injection as the second stage does not have restart capability. The effect of orbit inclination on payload capability is shown in Figure 2-4. This curve was generated assuming two-dimensional, in-plane launches (no doglegs or plane changes). The ETR range-safety restrictions allow launches between azimuth

TITAN IIIM LAUNCH VEHICLE

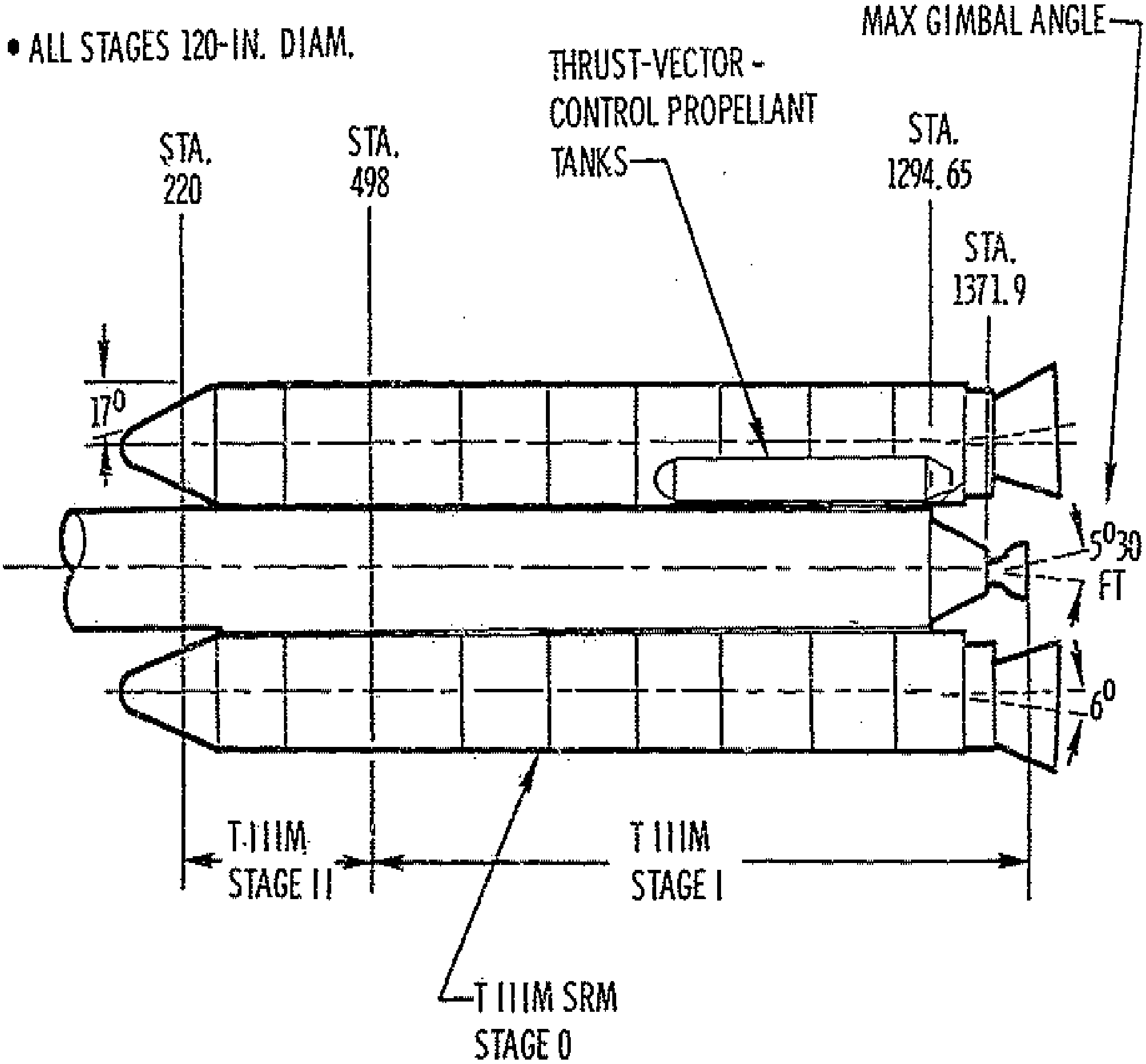

FIGURE 2-1

TITAN IIIM

MAJOR CHANGES FROM TITAN IIIC FOR PERFORMANCE IMPROVEMENTS

- SEVEN SEGMENT SRM INSTEAD OF FIVE SEGMENT
- FIRST STAGE ENGINE EXPANSION RATIO INCREASED FROM 8:1 TO 15:1
- FIRST STAGE PROPELLANT INCREASED BY 40,000 LB
- TRANSTAGE DELETED

MAJOR CHANGES FROM TITAN IIIC FOR MAN-RATING

- MALFUNCTION DETECTION SYSTEM
- ADDED REDUNDANCY IN THE CONTROL SYSTEM
- BACKUP LAUNCH GUIDANCE SYSTEM IN GEMINI B

FIGURE 2-2

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(GP-4)

TITAN IIIM
EFFECT OF ORBIT ALTITUDE
ON PAYLOAD

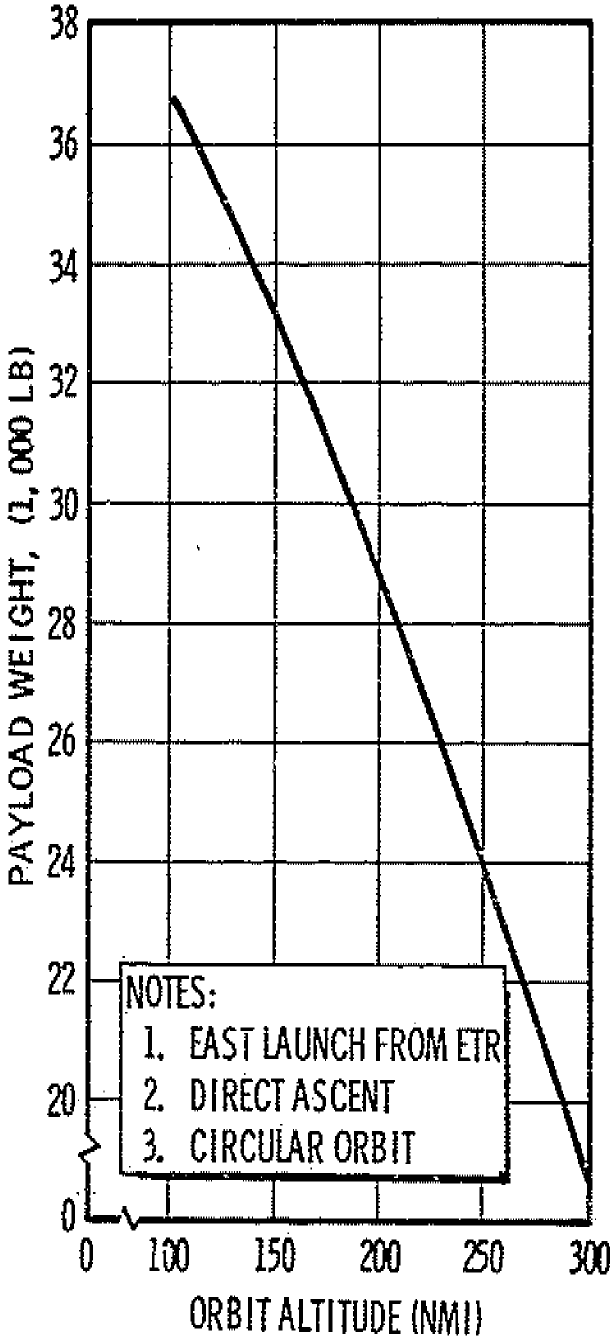

FIGURE 2-3

TITAN IIIM EFFECT OF ORBIT INCLINATION ON PAYLOAD

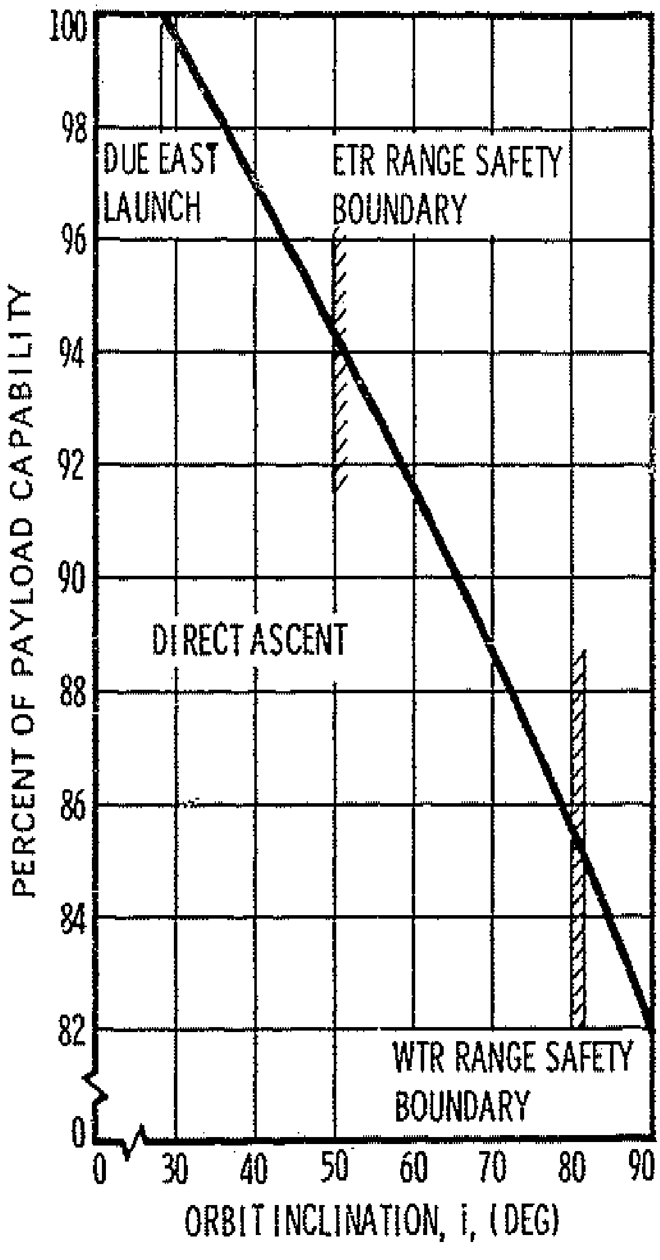

FIGURE 2-4

Section 3
GROUND SUPPORT SYSTEMS (U)

3.1 PURPOSE AND SCOPE (U)

(U) The purpose of this section is to describe the ground support systems required by the basic MOL mission. The systems have been divided into two functional areas: (1) the MOL launch facilities (MLF's) at Vandenberg Air Force Base, California, and (2) the United States Air Force Satellite Control Facility. The launch facilities, in turn, are divided into two primary functional areas: (1) Space Launch Complex No. 6 (SLC-6) and (2) MOL support facilities (MSF). The control facilities include the Satellite Test Center (STC), Sunnyvale, California, and remote tracking sites (RTS's) strategically located throughout the world to provide contact with the vehicle.

(U) The facilities are described only in sufficient detail to provide an assessment of their compatibility with NASA mission operations. In addition, operational activities are briefly described for prelaunch, launch, post-launch, and abort-recovery to illustrate how these facilities provide support.

3.2 MOL LAUNCH FACILITIES (U)

(U) The MLF's are functionally separated into two general areas: SLC-6 and the MSF's. Figure 3-1 is a representation of VAFB depicting the location of the MLF. The facilities within SLC-6 are outlined in the lower left corner of the figure. The MSF's are depicted within the industrial complex in the upper right corner of the figure. This section defines and describes those facilities within both areas that support the receipt, inspection, checkout, and launch of the launch vehicle (LV).

3.2.1 Space Launch Complex No. 6 (U)

(U) SLC-6 is located in the Sudden Ranch Area of South VAFB. Those facilities within SLC-6 that support LV operations are the launch complex, the launch

MOL LAUNCH FACILITY

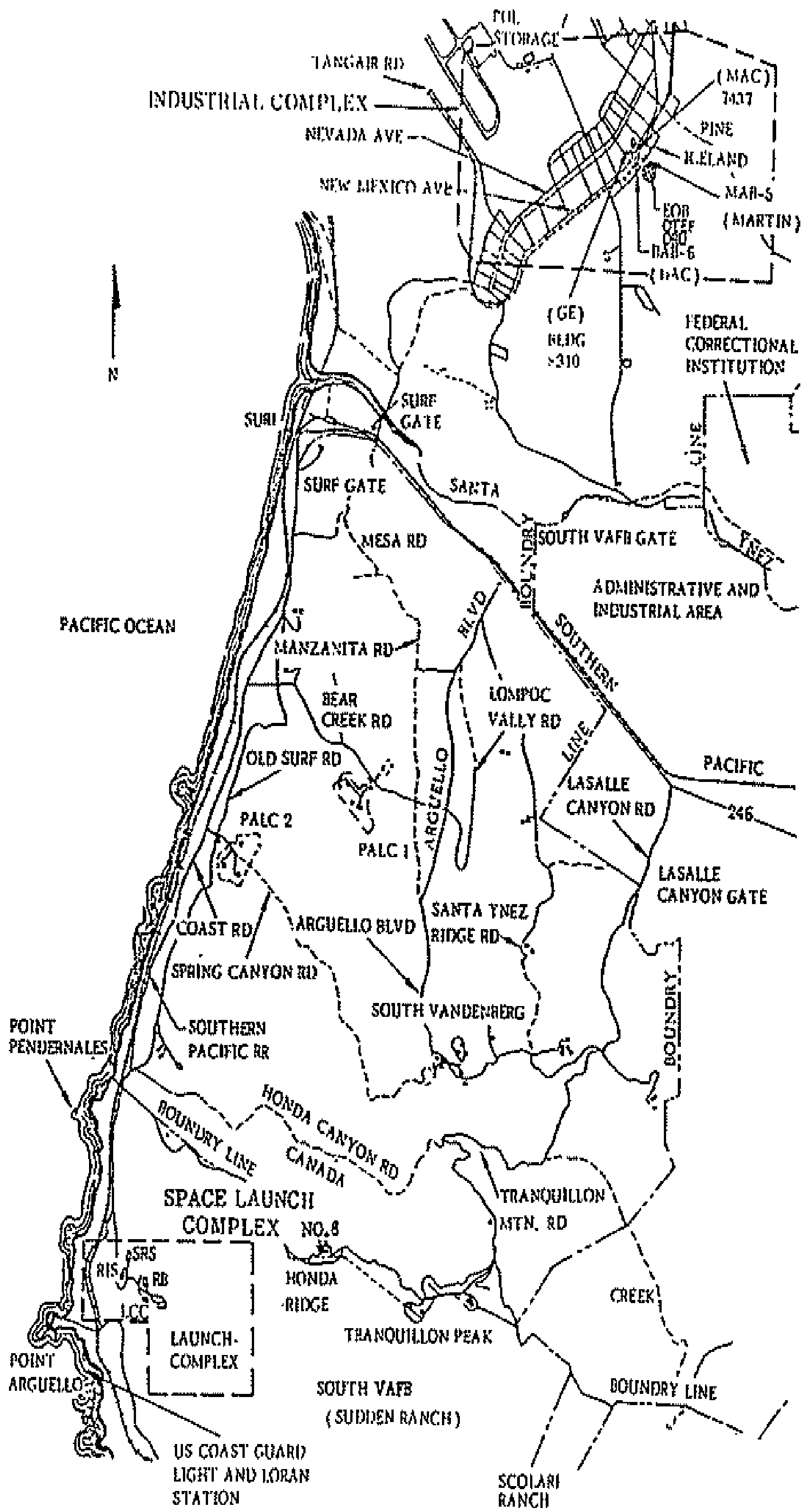

FIGURE 3-1

control center (LCC), the diesel power plant, the ready building, the segment receipt-inspection building, and the segment ready storage building.

3.2.1.1 Launch Complex (U)

(U) Facilities within the launch complex (Figure 3-2) that support the LV are described in the following paragraphs.

(U) The gas storage area provides storage for the nitrogen, oxygen, and helium used in the LV. The liquids and gases are handled in the area by cryogenic storage Dewar containers, gas storage vessels, liquid-to-gas converting units, and gas compressors. The gases are supplied to the LV through transfer lines from the storage area to the pressure controller room in the AGE building.

(U) The liquid oxygen area provides parking space for the liquid oxygen service unit during LV servicing operations. The service unit transfers the liquid hydrogen through flexible lines and connectors to the liquid hydrogen terminal panel and control console located within this area. The liquid hydrogen is transferred by vacuum-jacketed hard lines from the console to the valve complex on the UT.

(U) The oxidizer holding area provides parking space for the mobile oxidizer and flush fluids servicer. The servicer transfers the oxidizer to the UT for subsequent transfer to the LV attitude control and translation system/ propulsion (ACTS/PROP) subsystem.

(U) The fuel holding area provides parking space for the mobile fuel and flush fluids servicer. The servicer transfers the fuel or flush fluids to the UT for subsequent transfer to the LV ACTS/PROP subsystem.

(U) The AGE building provides two areas (Figure 3-3) housing the Douglas AGE items used to support LV checkout. Following are brief descriptions of the area and the equipment it contains:

1. Douglas Equipment Room--Room 105, located on the lower level of the building, contains rack-mounted electronic components of the Douglas all systems test equipment group (ASTEG). The ASTEG provides semiautomatic control and monitoring of the laboratory module (LM) subsystems during prelaunch and launch operations.

3.2.2.5 Operational Readiness Unit (U)

(U) The operational readiness unit (ORU) provides facilities for the following functions:

1. Living accommodations for eight flight crew members and two key mission personnel in a controlled-access building with crew quarters physically separated from key mission personnel quarters.

2. Physical restriction of the flight crew to limit interpersonnel contacts between the flight crew and medically unscreened individuals.

3. Continuation of the flight crew physical fitness program.

4. Recreation.

5. Prelaunch dietary management.

(U) The ORU is designed with regard for building layout and the relationship between living areas, exercise areas, and dining areas to meet the requirements for maximum medical surveillance of flight crew members during the training period.

3.3 SATELLITE CONTROL FACILITY (U)

(U) The responsibility for mission control is vested in a number of sites, designated the satellite control facility. This facility is composed of the Satellite Test Center (STC), seven remote tracking sites and three auxiliary voice stations located strategically around the world to provide the required vehicle contact.

3.3.1 Satellite Test Center (U)

(U) The STC is composed of a mission control center (MCC) and a recovery control center (RCC) for the purpose of monitoring and controlling the mission from launch to splashdown, in much the same manner as the NASA MCC in Houston, Texas. However, because of the limited number of sites and the projected large number of programs and vehicles, both manned and unmanned, individual bird-buffer computers (one for each program) have been included. With this equipment, each remote site sends and receives telemetry, tracking, command, and voice (TTCV) data to and from a great many vehicles.

Essentially the data arrives at a communication switch and is directed to the correct bird-buffer computer which computes the data, displays the processed information on printers for the test director and support groups in the control room, and prepares a copy of the data for a large off-the-line computer. Figure 3-10 depicts the flow of information at the STC.

3.3.2 Remote Tracking Sites (RTS) (U)

(U) The primary RTS's function as an extension of the MCC, collecting data from and transmitting data to the OV, under direction of the MCC. Station operations are automated and directly controlled by the MCC to the fullest extent practicable. However, the RTS will provide capability for backup control.

(U) The basic function of the RTS is to receive and relay TTCV data between the OV and the MCC. The ancillary functions are control and display (C&D), interstation communication, simulation and checkout, recording, and data handling processing.

(U) TTCV links for Gemini B, the LV, and the Titan III-M are required for the prelaunch, launch, ascent, on-orbit, and re-entry phases of the mission. During the early-ascent phase, data are relayed from the Gemini through the LV, and Vandenberg Tracking Station (VTS) when the vehicle is on the pad or below the VTS horizon. SGLS handover occurs during the ascent phase when the vehicle is in direct view of the VTS. As the vehicle moves down range there is a requirement to hand over C-band, S-band, command destruct, and other WTR support functions. This occurs during the ascent phase.

(C)(Gp 4) The insertion ship will provide VHF voice support to the flight crew through insertion and for two minutes thereafter. Pointing data may be derived from either C-band radars or from the S-band and telemetry autotrack systems. COMSAT will act as the relay to MCC.

(C)(Gp 4) The insertion ship will be required to provide voice command support to the flight crew. There is a possible requirement to command LV TTCV switch-over from the ship. It would be accomplished manually by the crew in response to a voice command. There is no requirement for the ship to have SGLS uplink command capability.

be accomplished are to (1) activate the LV subsystems and verify their proper operation, (2) verify proper performance of the LV as a FV segment throughout a simulated mission, and (3) verify that no adverse conditions exist as a result of the tests performed since the FV integrated systems test.

3.4.1.14 Launch Readiness Operations (U)

(U) The purpose of this function is to prepare the LV for countdown operations. The objectives to be accomplished are to (1) load propellants, pressurants, and cryogenics on board the LV, (2) connect and checkout the LV ordnance, (3) install and check out supplemental AVE, and (4) activate the primary power (fuel cells) on board the LV.

3.4.2 Launch Activities (U)

(U) The LV operations required to conduct the launch countdown are described in the following sections.

(U) The purpose of the LM portion of this function is to perform all operations that are necessary to (1) establish and maintain the LM in a flight configuration, (2) perform launch countdown for the LM, and (3) secure the LM AGE after launch. The objectives to be accomplished are to (1) establish the LM flight configuration, (2) support the FV launch, and (3) secure the LM AGE.

(U) LM Countdown Operations are as follows:

1. Perform electrical/electronic subsystems readiness test. Safety and warning circuits are maintained by hardwire link during the testing. For this operation, open loop is defined as the transmission of RF by waveguide from the LV antenna to the MST transmitting antenna.

2. Secure the LM for flight.

    A. Visually inspect the LM interior to verify that all valves and switches requiring manual operation are correctly positioned.

    B. Evacuate the launch crew personnel from the LM, remove the LM access kit, and secure the hatches.

    C. Purge the pressurized compartment and establish and monitor the atmosphere specified in (TBD).

3. Prepare the LM for flight.

   A. Visually inspect the flyaway umbilicals. Accomplish and verify the mechanical attachment of the lanyards.

   B. Disconnect and secure the remaining manual umbilicals.

4. Evacuate LM personnel from the launch pad.

5. Monitor, record, and evaluate LM critical parameters with respect to crew safety and mission objectives.

6. Test fire the ACTS to verify control and proper operation.

7. After liftoff, shut down all LM AGE and support the Martin Company verification of the safe pad condition.

3.4.3 Postlaunch Activities

(U) The postlaunch operations required to establish the LM AGE to the configuration required for receipt of the next Laboratory Vehicle are outline below. The general requirements for LM recycle operations are also indicated.

3.4.3.1 Turnaround Activities (U)

(U) The purpose of the LM turnaround activities is to establish the LM AGE configuration required for receipt of the next Laboratory Vehicle. The objectives to be accomplished are (1) assess launch damage and refurbish the LM AGE, and (2) modify as necessary and validate the LM AGE required for the next launch.

3.4.3.2 LM AGE Refurbishment (U)

(U) The LM AGE will be refurbished as required. Systems will be checked visually and defects will be corrected. Electrical systems will be energized and mechanical systems will activated in order to assess extent of damages. Pressure systems will undergo leak checks and repaired as required.

(U) LM AGE will be refurbished at the pad wherever possible. If complexity of damage requires more extensive repair, items will be moved to the maintenance area. Routine and preventive maintenance will continue at the pad during refurbishment activities.

3.4.3.3 Mission-Peculiar Modifications (U)

(U) Mission-peculiar modifications will be accomplished on existing LM AGE as required. New items will be received, inspected, and installed as necessary for subsequent operations.

3.4.3.4 AGE Verification (U)

(U) This function verifies that the LM AGE and facility meet their design specifications and that they are physically and functionally compatible with vehicle systems. AGE verification functionally demonstrates that each system or end item required to service, operate, or check out the LM is in an operational condition. During AGE verification, AF quality control personnel will witness and certify the AGE validation.

3.4.4 Abort-Recovery Operations (U)

(C)(Gp-4) In the event of a launch abort, both surface- and air-recovery forces will be stationed at close intervals along the first 1,000 mi of the launch trajectory. Upon achieving orbit, the launch-recovery forces will be dispersed. It is anticipated that the 14-hours stay time of the Gemini B will permit normal re-entry into one of the three recovery zones (Figure 3-11). These zones are located in the Atlantic, Pacific, and Indian Oceans. Recovery forces will be on station in these zones for the length of the mission. If, for some unforeseen reason, the Gemini B must re-enter during some other than one of the 6 to 10 orbits/day which would land the vehicle in a designated zone, then the World-Wide Air Rescue Service (ARS) would be utilized to rescue the crewmen.

(GP-4)

MOL BASELINE RECOVERY PLAN (U)

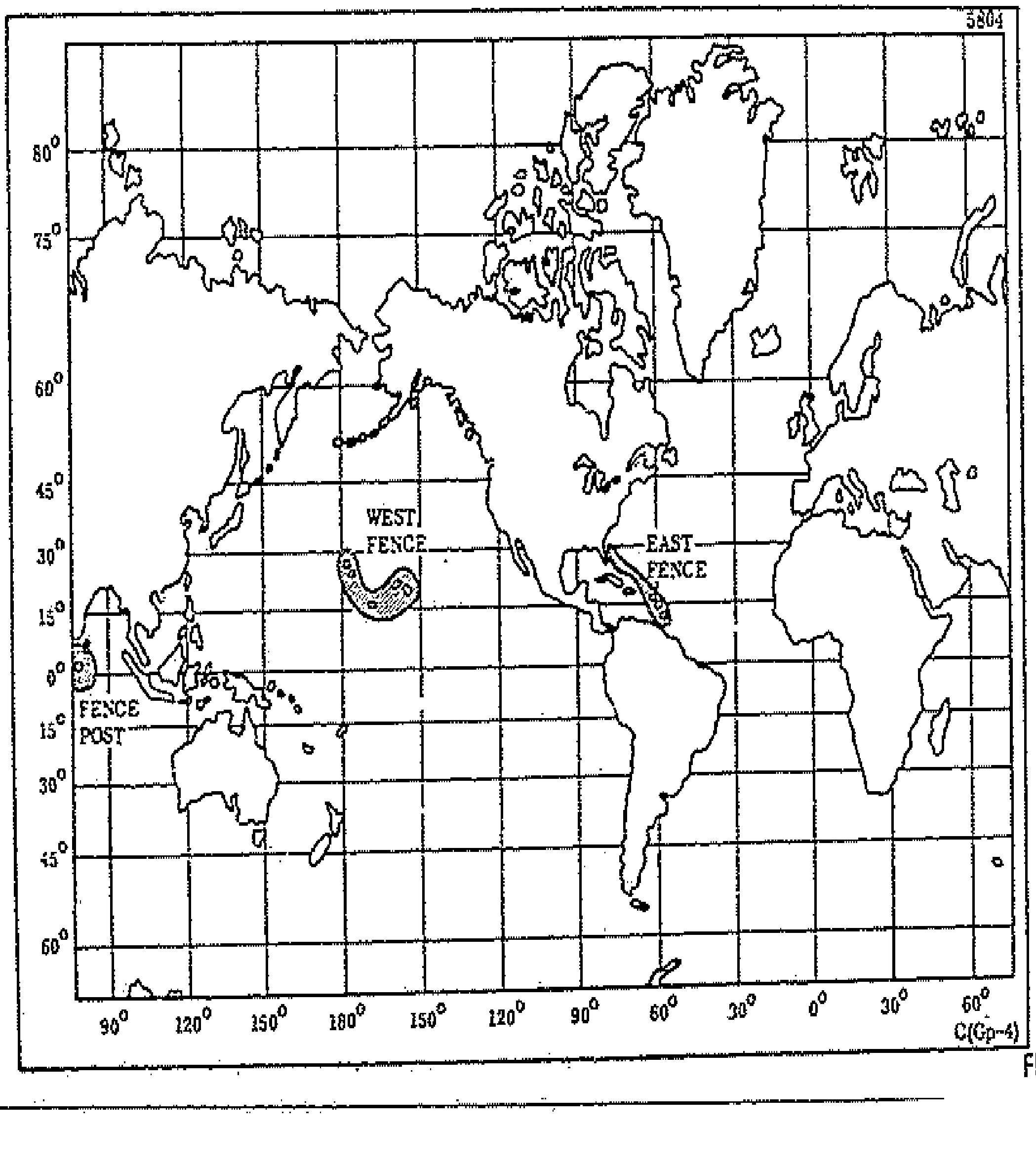

FIGURE 3-11